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THE CHAÑARES (ARGENTINA) TRIASSIC REPTILE FAUNA IX. THE CHANARES FORMATION

Alfred Sherwood Romer

ABSTRACT. The term "Chañares Formation" should be retained for the fossiliferous beds so named by Romer and Jensen; the type section of the "Ischichuca Formation" is homologous with part of the overlying Los Rastros Formation.

With the discovery of a rich Triassic reptilian fauna in the Chañares-Gualo region of La Rioja Province, Mr. James Jensen and I set about the task of determining the stratigraphic sequence of the area (Romer and Jensen, 1966). It was soon apparent that, despite complex faulting, a series of formations with clear-cut boundaries could be distinguished, and in the Arroyo del Agua Escondida the entire local series could be seen in proper sequence.

The area is part of a basin of late Paleozoic and early Mesozoic deposition lying in western La Rioja Province and an adjacent portion of San Juan, extending roughly from the western flanks of the Sañogasta Range on the east to the Río Bermejo on the west, and from the region of Villa Unión south to the northern end of the Valle Fertil range. The center of this area is the flat Campo de Talampaya, and I shall term this cuenca the Talampaya Basin. Little attention had ever been given to the geology of our area of interest in the eastern part of the basin, but considerable work had been done in the western part. It was obvious that the thickness and nature of the sediments varied greatly from one basin area to another, and the situation was further complicated by the fact that there had been much volcanic activity. As far as possible we utilized formation names already in the literature; when no similarities to named formations in other areas in the basin were discernible, new names were given. The formations named by us are shown in the right hand column of the table. The

three formations latest in time — Los Colorados, Ischigualasto¹ and Los Rastros — are comparable to those so named to the west, across the Campo de Talampaya, although much thinner in our area in each instance. Below the normal beds of the Los Rastros, strongly carbonaceous in nature, are some 70 meters of evenly bedded volcanic ash sediments in which fossil reptiles are abundant. Despite the fact that these strata are quite conformable with the overlying Los Rastros deposits, they are, as layers of white to bluish white ash, quite distinctive in character and, since they are the bearers of our fauna, we ventured to separate them from the Los Rastros as a distinct Chañares Formation. Below them, unconformably, are red and white sandstones which are roughly comparable to those generally assigned to "Paganzo III." Since this is not a proper stratigraphic term, we have given them the name of the Tarjados Formation. Beneath them, again, are thick series of soft sandstones, perhaps also part of the "Paganzo III" complex, for which we have found no clear equivalents in other parts of the basin, and which we have named the Talampaya Formation.

In general, I think, this terminology has been accepted. The one exception is that Sr. Bonaparte (1967, 1969, etc.) has objected to our term "Chañares Formation," and maintains that these beds should bear the name "Ischichuca Formation." Despite the high regard I have for Sr. Bonaparte's work in the collection and description of Triassic fossils, I believe that this usage is indefensible. A review of the history of stratigraphic work in this region is necessary.

The first serious study of this region was that of Bodenbender (1911). His stratigraphic section in this basin is given in the first column of the table. He believed that the sediments in this area extended from the Carboniferous to the Cretaceous, and for the lower beds in the region invented the term "Paganzo," divided into "Paganzo I" for light colored sediments which he believed (apparently correctly) to be of Carboniferous age, "Paganzo II," for red sandstones which (again probably correctly) he thought were Permian, and "Paganzo III," for beds, mainly reddish sandstones, which (with less assurance) he claimed to be Triassic.

¹ Sr. R. R. de la Vega has pointed out to me that the correct spelling should be Ichigualasto, but the "improper" version has become so embedded in the literature that it seems impossible to eradicate it.

"Rhaetic" was a favorite term with early German workers in South American geology, favored perhaps because of its rather vague meaning, and to the "Rhaetic" he assigned a very considerable thickness of beds including yellow and variegated shales, coal shales, and coal seams. Above these (beyond some indeterminate beds in the region of Cerro Morado, which he suggested were possibly Jurassic) the depositional series terminated with thick red sandstones which he believed to be Cretaceous in age and termed the "Cretáceo Andino."

A more thorough study of the beds of the western part of the basin was undertaken in the 1940's by Frenguelli and by de la Mota. Frenguelli mainly visited the region of the Ischigualasto Valley, drained to the west by the Río de la Peña, and published his results in 1948. Bodenbender's "Cretáceo Andino" beds were termed by him the "Estratos de Gualo," and their presumed age reduced, reasonably, from Cretaceous to "Rhaetic." In Bodenbender's erstwhile "Rhaetic" series he distinguished an upper member as the Ischigualasto Formation — a series of variegated shales and some sandstones characteristic of the Ischigualasto Valley west of the red bluffs of the "Gualo." These beds are now known to possess a very considerable fauna of Triassic (? Ladinian or possibly Carnian) age. Below the Ischigualasto, to the west, and traversed by the difficult gorge of the La Peña, are rugged hills of sandstones and shales including coal seams, in which footprints had been discovered (Huene, 1931). As Frenguelli notes (1948: 191), he did not penetrate much farther to the west through the rugged country in the Ischigualasto-La Peña region than the Quebrada de los Rastros, where a coal mine is located and where the footprints were found; some data were furnished him by Ramaccioni and Heim, who studied the coal beds (Heim, 1949). They informed him that these "Rhaetic" beds were underlain, to the west, by red "Paganzo" sandstones which he cites as "Paganzo II" (they are actually of "Paganzo III" age).

The total thickness of the "Rhaetic" beds below the Ischigualasto Formation in this region was estimated as 600–650 meters. Frenguelli made this area the type section of the Los Rastros Formation, to which he assigned the upper 400–450 meters of these beds — i.e., about two-thirds, on his reckoning. As can be seen from the sections of Ortiz, mentioned later, under this definition of the Los Rastros the formation would include essentially

the whole of the coal-bearing portion of the "Rhaetic" beds. In default of personal knowledge of the lower beds in the Ischigualasto-La Peña region, Frenguelli turned to the region of Cerro Bola, some 70 km to the north, which had been studied in detail by de la Mota (whose results are recorded in an unpublished thesis at the University of La Plata).¹ Equivalents of the "Gualo" and Ischigualasto beds are readily determinable in the Cerro Bola region. Between the Ischigualasto and "Paganzo III" there are here, much as in the Ischigualasto region, some 500–550 meters of "Rhaetic" beds of sandstones, shales, and coal seams. The upper 250–300 meters of these beds were equated by de la Mota and Frenguelli with the type Los Rastros; they contain occasional carbonaceous seams, but consist mainly of shales and fine-grained olive-green sands. The beds below, with a thickness of about 250 meters, are here the main coal-bearing strata, dominantly black or grey-black in color, with some intercalations of thin olive-green sands. These beds were named the Ischichuca Formation, the type section being located in the quebrada of that name south of Cerro Bola. Below the Ischichuca Formation lies "Paganzo III." This consists mainly of coarse red sandstone and intercalated volcanic beds; between the beds of "Paganzo III" proper and the Ischichuca are 30–40 meters of coarse grey to reddish conglomerates which de la Mota assigned to "Paganzo III."

Frenguelli's sections of the basin, derived from two areas 70 km apart, are given in the second and third columns of our table. In 1953 Groeber and Stipanovic (pp. 87–93), in their review of the Triassic, followed Frenguelli, as given in our column 4, except that his "Estratos de Gualo" are renamed "Estratos de los Colorados," (since de la Mota had pointed out to them that the Mogote del Gualo lies at a much lower stratigraphic position than Frenguelli believed).

A decade later than the visit of Frenguelli to the Talampaya Basin, study of the region to the west of Ischigualasto, down the La Peña, was undertaken by Ortiz on behalf of the Yacimientos Petrolíferos Fiscales. His work was done in 1964, and his sections and maps were promptly circulated, although publication of his work was not made until 1968. As his sections show, the actual

¹ Resúmenes of de la Mota's findings are given by Frenguelli (1948: 197–208) and by Groeber and Stipanovic (1953: 93–95).

sequence of the "Rhaetic" beds here, below the Ischigualasto, differs considerably from that imagined by Frenguelli and studied by him in the Cerro Bola region, and the strata are considerably thicker than had been believed. The upper part of the type Los Rastros Formation, to about 250 meters, consists mainly of grey sandstones with intervening shales and only a few coal seams. Below this, but also included by Frenguelli — entirely or at least for their most part — in the type section of the Los Rastros Formation are about 400 meters of beds in which dark carbonaceous shales and coal seams predominate, with intervals of olive-green shales. Below the coal beds, again, are about 450 meters of conglomeratic sandstones, light in color, in which coals are little developed. Still farther down to the west appear the red sandstones of "Paganzo III."

It is clear that Frenguelli's nomenclature of the Los Rastros and Ischichuca beds in the two regions, that of the La Peña and the Ischichuca quebrada, is conflicting. The beds assigned to the Los Rastros in the Ischichuca region include only the upper part of the type Los Rastros; the middle, coal-bearing section of the beds which were included in the type Los Rastros in the La Peña region, form to the north practically the entire Ischichuca Formation. The lowest portion of the "Rhaetic" beds in the La Peña area has no counterpart in the north, unless it be the thin series of conglomerates that were mentioned above as transitional from "Paganzo III" to Ischichuca. As Ortiz points out, the entire series of beds from "Paganzo III" up to the Ischigualasto forms a single cycle of deposition, to the whole of which the formation name Los Rastros should properly be applied. Further, since the supposed Ischichuca Formation is merely a portion of the Los Rastros — the lower portion by Frenguelli's definition, the middle portion under Ortiz's suggestion — the term "Ischichuca" should be abandoned, as simply a partial synonym of Los Rastros.

The Triassic sequence in the Talampaya-Ischigualasto basin as interpreted by Ortiz is given in column 5 of our table. Our own interpretation, given in column 7 and mentioned earlier, is in most regards comparable. The identity of the Los Colorados and Ischigualasto formations is perfectly clear; we have given names, as the Tarjados and Talampaya formations, to the red sandstones and underlying finer sandstone beds that have previously been referred to under the vague generic term "Paganzo III." We have, with Ortiz, agreed that the coal-bearing sandstones and shales of

the "Rhaetic" should be considered as a single Los Rastros Formation rather than be subdivided in two in a confusing fashion. Our one difference has been in distinguishing the lowest part of this cycle as a separate Chañares Formation because of its distinctive nature and, especially, because of the paleontological importance of this unit.

Bonaparte, independently of Ortíz, studied the lower western portion of the beds which Ortíz has described and, like Ortíz and in contrast to Frenguelli's hypothetical interpretation, finds that the lower part of the Los Rastros complex consists of light colored shales without coal seams, and thus is somewhat comparable to our Chañares beds. He is, further, to be congratulated for finding in them fossils which are presumably comparable to those from the Chañares. Quite probably the lowest section of the Los Rastros of Ortíz and the Chañares beds are homologous (although the Los Rastros beds contain conglomerates, quite in contrast with the even bedding of the Chañares). How should the matter be treated? It may be advocated either that the Chañares be considered as a lower member of the Los Rastros or that the lower segment of the Los Rastros in the La Peña area be considered as a separate Chañares Formation.

Bonaparte, however, would go further and revive the term "Ischichuca" for these beds. Essentially, his argument is that since these beds in the La Peña region were termed Ischichuca by Frenguelli (who had never seen them and was ignorant of their nature), the name should be retained. To so argue, however, is to violate the basic principles of stratigraphic nomenclature. One should refer to the type section of the Ischichuca, 70 km to the north. The type Ischichuca consists of the main coal-bearing section of the "Rhaetic." As Ortíz has shown, the supposed "Ischichuca" in the La Peña region is at a higher stratigraphic level than the beds with which we are concerned and is, by Frenguelli's definition, equivalent to part of the Los Rastros. No two sets of beds could differ more in nature than the blackish "coal measures" of the Ischichuca and the clear white ash of the Chañares. Both the nature of the beds and their stratigraphic position distinguish clearly the type "Ischichuca" from the lower Los Rastros and Chañares beds. The use of "Ischichuca" for the latter strata cannot be defended.

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| Bodenbender 1911 | Frenguelli 1948 | Groeber & Stipanovic 1953 | Ortiz 1964, 1968 | Bonaparte 1967, 1969 | Romer & Jensen 1966 |
| | Ischichuca | La Peña | | | |
| Cretacea Andino | Gualo | | Los Calarados | | |
| Ischigualasto | | | | | |
| Rhaetic | Los Rastros | Los Rastros type locality | | Los Rastros | |
| | Ischichuca type locality | Ischichuca | | Los Rastros | |
| | Paganzo III | | Paganzo III | | Chañares |
| | | | | | Tarjados |
| | | | | | Talpampaya |

Table to show various interpretations of the Triassic sequence in the Talpampaya Basin.

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